

## LETTER TO THE EDITOR

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#### **Focusing on Single CT Perfusion Quantitative Maps: Percheron's Artery Stroke Detection**

**Keywords:** Ischemic stroke, Percheron artery, CT perfusion, Neuroimaging

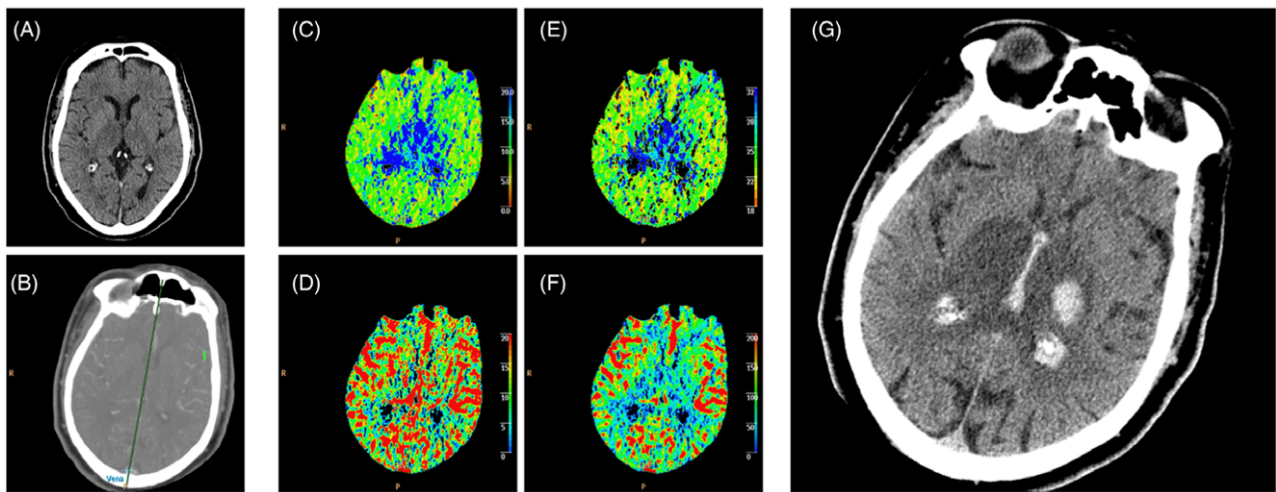
Artery of Percheron is a rare anatomical variant of the posterior brain circulation, in which a single perforating artery, originating by P1 segment of either one of the two posterior cerebral arteries, vascularizes both paramedian territories of the thalami and upper brainstem. As a consequence, an occlusion of this vascular trunk results in bilateral infarction of paramedian thalami with or without upper midbrain involvement. This condition may occur with a variety of neurological symptoms, the most frequent of which are vertical gaze palsy (65%), memory impairment (58%), and coma (42%).<sup>1</sup> Strokes in the Percheron's artery territory account for about 0.1–2% of all ischemic strokes and for 4–18% of all thalamic infarcts.<sup>2</sup> Nonenhanced computed tomography (NECT) and CT angiography have very low sensibility for this type of occlusion, mainly due to the small size of the artery, so diagnosis is often missed or made retrospectively in the later stage.<sup>3</sup> CT perfusion (CTP) may allow to identify this condition in the emergency setting. Nevertheless, there is limited information on CTP pattern during Percheron's artery stroke.<sup>4</sup> In this case report, we reported an atypical clinical presentation of Percheron artery occlusion (mimicking total anterior circulation syndrome), and we discussed the CTP maps pattern that may have compromised the neuroradiological interpretation.

A 58-year-old man was found at awakening with the following symptoms: drowsiness, muticism, right hemiplegia and hemianesthesia, right homonymous hemianopsia, and right facial nerve paralysis (NIHSS = 19), without any ocular gaze deviation. Anamnestic evaluation revealed that the patient presented a sudden speech impairment from the previous afternoon (that did not resolve), for which medical assistance was not sought. Further anamnestic details included obesity, type 2 diabetes, atrial fibrillation (in treatment with 60 mg/d Edoxaban; the last sure intake of the direct-acting oral anticoagulants was at 8 am in the previous morning), and arterial hypertension. At admission, the patient underwent multimodal imaging including NECT, CT angiography, and CTP, all reported without alterations. CTP data were acquired and processed as previously described.<sup>5</sup> In particular, CTP was reported as negative due to the absence of alterations in the core/penumbra summary map, which was calculated according to the Wintermark et al. asymmetry criteria.<sup>6</sup> However, a subsequent analysis of single CTP maps, namely CBV, CBF, MTT, and TTP, revealed a bilateral symmetrical thalamic hypoperfusion in TTP, CBF, and MTT, without any CBV alteration. The patient was not treated with thrombolysis due to

the late admission (>12 h from symptoms onset) and received supportive care only (acetylsalicylic acid 250 mg IV and prophylactic enoxaparin 4000 IU). The diagnostic work-up (including echocolor doppler, electrocardiogram, and echocardiography) showed nothing but atrial fibrillation, likely the cause of the stroke. The following day the neurological deficit remained stable and follow-up NECT at 24 h showed bilateral thalamic hypodensity without any lesion in middle cerebral artery territory. On the fourth day, respiratory failure and a further decrease in consciousness occurred (GCS 3), requiring urgent NECT that showed intraparenchymal left thalamic hemorrhagic infarction and tetraventricular and subarachnoid hemorrhage. Due to the gravity of the clinical picture, the patient was then transferred to the intensive care unit, where he died for the severe respiratory failure.

The clinical presentation of Percheron's artery occlusion may vary. Besides the classical triad (vertical gaze palsy, consciousness alteration, and memory disorder), other signs and symptoms are reported in literature, including oculomotor and movement disorders, cerebellar ataxia, hemiplegia, and speech disturbances.<sup>2</sup> Our case presented total anterior circulation syndrome (TACS) related symptoms, suggestive of infarct in the territory of the middle cerebral artery, which was excluded by the radiological assessment. Moreover, CTP assessment based only on the core/penumbra summary map was reported as negative, while a detailed analysis of single CTP parameters maps revealed bilateral symmetrical thalamic marked hypoperfusion in TTP, CBF, and MTT, but no CBV alteration (Figure 1). This pattern is suggestive of penumbra in the Percheron's artery territory. This symmetrical alteration of MTT/TTP/CBF/CBV maps yields a negative core/penumbra summary map if the software criteria is based only on the asymmetry-based thresholds, as in most of the vendor software. Our center adopted the MTT asymmetry-based threshold (>145% of contralateral hemisphere<sup>6</sup>) to detect the hypoperfused tissue. If single maps containing absolute values of MTT/TTP/CBF/CBV perfusion-related parameters are not taken into account, the median vascular territories (like bithalamic hypoperfusion in this case study) are not visualized on the summary map due to symmetrical abnormalities. The neuroradiological reporting should be based on complete CTP analysis, which require both the acknowledgment of the automatic core/penumbra summary maps' pitfalls and the evaluation of all calculated MTT/TTP/CBF/CBV maps.<sup>7</sup> The quantitative and qualitative analysis of single CTP maps may improve diagnostic accuracy.<sup>7,8</sup>

In conclusion, the case report aims to highlight the possibility of early diagnosis of Percheron's artery occlusion using advanced perfusion neuroimaging. Particularly, a focused qualitative and quantitative analysis of the CTP patterns on both parametric and summary prognostic maps is fundamental to avoid misinterpretations in case of symmetrical hypoperfusion neuroimaging patterns. Although rare, this type of occlusion should be borne in mind as it may occur with various and confounding symptomatology.



**Figure 1:** (A) NECT at admission reported as normal. A further detailed analysis revealed a slight hypodensity of thalami; (B) CTP core/penumbra summary map was reported as negative; quantitative CTP parameters maps: (C) mean transit time – MTT, (D) cerebral blood volume – CBV, (E) time to peak – TTP, (F) cerebral blood flow – CBF. CTP quantitative maps revealed bilateral symmetrical thalamic marked hyperperfusion with an increase in TTP, CBF, and MTT and preserved CBV; (G) follow-up NECT showed a bilateral hypodensity in thalami with left hemorrhagic transformation and ventricular and subarachnoid hemorrhage.

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#### CONFLICT OF INTERESTS

None.

#### STATEMENT OF AUTHORSHIP

TC: Conceptualization, methodology, data curation, writing – original draft preparation. GF: Conceptualization, methodology, data curation, writing – original draft preparation. ABS: Conceptualization, methodology, data curation, writing – original draft preparation. CL: Visualization, investigation. PC: Visualization, investigation. RPM: Software, data Curation. MN: Conceptualization, supervision. PM: Conceptualization, project administration.

#### ETHICAL STATEMENT


The research was conducted according to the principles of the Declaration of Helsinki. Patient’s surrogate released informed consent to participate in the study after the scope of the research had been fully explained.

#### INFORMED CONSENT

Informed consent was obtained from all individual participants included in the study.


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